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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PTREFIL014WO	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/EP2004/052609	International filing date (day/month/year) 21.10.2004	Priority date (day/month/year) 22.10.2003
International Patent Classification (IPC) or national classification and IPC D07B7/02		
Applicant TREFILARBED BETTEMBOURG S.A. et al.		
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau) a total of 6 sheets, as follows:</p> <p><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>		
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>		
Date of submission of the demand 28.04.2005	Date of completion of this report 12.01.2006	
Name and mailing address of the international preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer D'Souza, J Telephone No. +31 70 340-4236 	

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/EP2004/052609

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1, 4-9	as originally filed
2, 3, 3a	filed with telefax on 15.09.2005

Claims, Numbers

1-12	filed with telefax on 15.09.2005
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Drawings, Sheets

1/3-3/3	as originally filed
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- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/EP2004/052609

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-12
	No: Claims	
Inventive step (IS)	Yes: Claims	1-12
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-12
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

Reference is made to the following document:

D1: WO 02/088459 A (BEKAERT SA NV ; CAUWELS HANS (BE); VANNESTE STIJN (BE); MEERSSCHAUT DI) 7 November 2002 (2002-11-07)

1 Claim 1 - Novelty (Article 33(2) PCT)

- 1.1 The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and discloses (the references in parentheses applying to this document):

A method for manufacturing a wire cord, said method comprising the steps bundling a plurality of wires in a bundling means; crimping said wires between meshing toothed surfaces; and twisting together said plurality of crimped wires along a twisting path;

- 1.2 The subject-matter of claim 1 therefore differs from this known method in that said bundling is carried out in such a way that said wires lie closely side-by-side in one plane; and said crimping is carried out by passing said plurality of wires between meshing toothed surfaces located at the beginning of said twisting path.

- 1.3 The subject matter of claim 1 is therefore novel (article 33(2) PCT).

1 Claim 4 - Novelty (Article 33(2) PCT)

- 1.1 The document D1 is regarded as being the closest prior art to the subject-matter of claim 4, and discloses (the references in parentheses applying to this document):

A machine for manufacturing a wire cord, said machine comprising:
a bundling means for bundling a plurality of wires;
a crimping means, downstream of said bundling means, comprising crimping

wheels with meshing toothed surfaces for crimping said wires; and
a twisting means for twisting together said wires along a twisting path.

1.2 The subject-matter of claim 4 therefore differs from this known machine in that said bundling means is configured in such a way as to force said plurality of wires to lie closely side-by-side in one plane; and said crimping means comprises a pair of crimping wheels with meshing toothed surfaces that is located at the beginning of said twisting path.

1.3 The subject matter of claim 4 is therefore novel (article 33(2) PCT).

2 Claims 1 and 4 - Inventive step (Article 33(3) PCT)

2.1 The problem to be solved by the present invention may be regarded as being to more efficiently manufacture a wire cord comprising crimped metallic wires by preventing smoothing of the crimped wires before they are twisted together.

2.2 The solution to the problem proposed in claim 1 of the present application is considered to involve an inventive step (Article 33(3) PCT), because in the available prior art it is neither known nor suggested to commence twisting together of the wires between the meshing toothed surfaces of the crimping wheels.

3 Dependent Claims

Claims 2, 3 and 5 - 12 are dependent on claims 1 and 4 respectively and as such also meet the requirements of the PCT with respect to novelty and inventive step.

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a pair of gear-like wheels. Downstream of the gear-like wheels the crimped wires pass through through-holes in a stationary plate before they are introduced into a twisting machine that twists them together into a steel cord. This method has major drawbacks, too. The toothed wheels can only provide a relatively flat deformation of the wires without risking to damage them. Furthermore, the stationary plate guiding the crimped wires into the twisting machine has a tendency to smooth them again.

Also US 6,311,466 discloses crimping the wires between toothed wheels. However, instead of using only one pair of toothed wheels, one suggests to use a second pair of toothed wheels that is placed next to the first pair in order to pre-form the wire in a plane turned by 90 degrees compared to the first crimping plane and with a different pitch than the first pair. Each wire passes through a separate toothed wheels arrangement. Thereafter, the crimped wires are bundled and introduced into a known twisting machine to be twisted together. According to US 6,311,466, the individual steel wires should thus receive a spatial deformation before they are twisted together, which is said to improve rubber penetration, to increase elongation at rupture and to decrease the stiffness of the cord. It will, however, be appreciated that the wire has a tendency to tilt when it leaves the first pair of toothed wheels. Thus, the second pair of toothed wheels tends to generate the second wave in the same plane as the first wave, which partially ruins the expected advantages. Moreover, this method also suffers from a smoothing back of the crimped wires prior to the final twisting operation.

WO 02/088459 discloses a method for manufacturing a wire cord comprising the steps of bundling a plurality of wires in a bundling means; crimping the wires between meshing toothed surfaces; and twisting together the plurality of crimped wires along a twisting path.

OBJECT OF THE INVENTION

The object of the present invention is to provide a method and a machine for more efficiently manufacturing a wire cord comprising crimped metallic wires

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that are twisted together.

This object is achieved by a method as claimed in claim 1, respectively a machine as claimed in claim 4.

SUMMARY OF THE INVENTION

In accordance with an important aspect of the present invention, the crimping is carried out by passing a plurality of wires between meshing toothed surfaces that are located at the beginning of the twisting path, along which the wires are twisted together. This feature allows to obtain excellent results with regard to the elongation at rupture of the cord and elastomer penetration into the cord. There is no smoothing of the crimped wires before they are twisted together and there is a very homogeneous distribution of the crimping waves in the twisted cord. Furthermore, the method in accordance with the present invention can be carried out with very simple crimping equipment, it does not need complicated adjustments and it allows to obtain very good productivity results.

The plurality of wires shall be closely bundled so that they lie closely side-by-side in one plane before they are crimped between the meshing toothed surfaces, and the twisting together of the wires shall preferably already start between the meshing toothed surfaces of the crimping wheels. The plurality of wires shall still lie closely side by side in one plane at the entrance of the meshing toothed surfaces of the crimping wheels, whereas at the outlet of the meshing toothed surfaces, the wires shall already be crossing one another.

A machine for manufacturing a cord in accordance with the present invention has a crimping means with crimping wheels with meshing toothed surfaces for crimping the wires and a twisting means for twisting together the wires along a twisting path. In accordance with an important aspect of the present invention, the crimping means comprises a pair of crimping wheels with meshing toothed surfaces that is located at the beginning of the twisting path, and the machine also comprises bundling means located upstream of the pair of crimping wheels for closely bundling a plurality of wires in such a way as to

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force the plurality of wires to lie closely side-by-side before passing them between said toothed surfaces at the beginning of said twisting path.

The bundling means is preferably a bundling die with an aperture that is dimensioned in such a way as to force the plurality of wires to lie closely side by side. Good results are achieved if the bundling means is located between 30

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Claims

1. A method for manufacturing a wire cord, said method comprising the steps of:
bundling a plurality of wires in a bundling means;
crimping said wires between meshing toothed surfaces; and
5 twisting together said plurality of crimped wires along a twisting path;
characterised in that
said bundling is carried out in such a way that said wires lie closely side-by-side in one plane; and
said crimping is carried out by passing said plurality of wires between mesh-
10 ing toothed surfaces located at the beginning of said twisting path.
2. The method as claimed in claim 1, wherein said twisting together starts between said meshing toothed surfaces.
3. The method as claimed in claim 1 or 2, wherein:
at the entrance of said meshing toothed surfaces, said wires still lie closely
15 side-by-side in one plane; and
at the outlet of said meshing toothed surfaces, said wires are crossing one another.
4. A machine for manufacturing a wire cord, said machine comprising:
a bundling means for bundling a plurality of wires;
20 a crimping means, downstream of said bundling means, comprising crimping wheels with meshing toothed surfaces for crimping said wires; and
a twisting means for twisting together said wires along a twisting path;
characterised in that
said bundling means is configured in such a way as to force said plurality of
25 wires to lie closely side-by-side in one plane; and

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said crimping means comprises a pair of crimping wheels with meshing toothed surfaces that is located at the beginning of said twisting path.

- 5 5. The machine as claimed in claim 4, wherein said bundling means is a bundling die with an aperture, said aperture being dimensioned in such a way as to force said plurality of wires to lie closely side-by-side in one plane.
6. The machine as claimed in claim 4 or 5, wherein said bundling means is located between 30 mm to 60 mm from the point where said plurality of wires enter between said meshing toothed surfaces.
- 10 7. The machine as claimed in any one of claims 4 to 6, wherein in said meshing toothed surfaces two successive teeth with a tooth thickness t are separated by a gap with a gap width g , and said tooth thickness t and said gap width g satisfy following relation: $2t < g < 4t$.
- 15 8. The machine as claimed in claim 7, wherein said wires have a diameter D and said tooth thickness t and said diameter D satisfy following relation: $2D < t < 4D$.
9. The machine as claimed in any one of claims 4 to 8, wherein said wires have a diameter D between 0,2 and 1,0 mm.
- 20 10. The machine as claimed in any one of claims 4 to 9, wherein the distance between said crimping wheels in said pair is adjustable, so that the penetration of the teeth of one wheel into the gaps of the other wheel is adjustable.
11. The machine as claimed in any one of claims 4 to 10, wherein said twisting means comprises:
a rotor that can be rotated about a rotor rotation axis; and
25 a deflection pulley supported on said rotor, said deflection pulley forming the end of said twisting path, wherein the latter is substantially co-axial to said rotor rotation axis.
12. The machine as claimed in any one of claims 4 to 11, further comprising:
a support structure;

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a rotor with a first rotor end and a second rotor end, said rotor being supported by said support structure in such a way as to be capable of rotating about a rotor rotation axis;

5 a cradle supported between said first rotor end and said second rotor end, in such a way as to be capable of freely rocking about said rotor rotation axis, whereby said cradle remains immobile in rotation when said rotor is rotated;

a plurality of wire unwinding devices supported by said cradle;

10 guiding means on said cradle for guiding a plurality of wires from said unwinding devices towards said pair of crimping wheels, said pair of crimping wheels being mounted on said cradle in such a way as to be substantially aligned with said rotor rotation axis;

15 a first deflection pulley supported on said first end of said rotor, in such a way as to be capable of twisting together said plurality of wires in said twisting path, which extends from said first deflection pulley to said pair of crimping wheels;

20 a first flyer arm connected to said first rotor end and a second flyer arm connected to said second rotor end, said first and second flyer arm being capable of guiding the twisted wires about said cradle from said first rotor end to said second rotor end;

a second deflection pulley supported on said second end of said rotor, in such a way as to be capable of guiding said twisted wires coming from said second flyer arm axially out of said second rotor end; and

a pulling means for pulling said twisted wires out of said second rotor end.